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AN EXPERIMENT ON THE SIZE OF THE EARTH

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AMONG certain experiments in mathematical geography in which the writer has become interested, two, one on earth sphericity, the other on earth size, are believed to have more than a personal value. In an account of the experiment on the rotundity of the earth,[1] a simple but effective method of showing earth curvature was outlined. No attempt was made in the experiment at quantitative work. In more recent experiments the obtaining of sufficient data to calculate the size of the earth was the object.

The experiment was performed on Lake Quinsigamond, a long and narrow lake on the eastern boundary of Worcester, Massachusetts. The surface of the lake is dotted by a number of small islands, and numerous salients are the feeding grounds of bars which extend into the deeper waters. All these make the performance of the experiment relatively easy as they furnish a variety of choice for stations to accommodate the different parts of the apparatus. In the previous experiment, on earth sphericity, no effort was made to fix on points equally distant from the central location. The apparatus was set up in line with certain marked points (STU, Fig. I) at a uniform distance above the water surface and a sighting was taken along the points. In the later experiments stations were selected at more regular intervals. The accompanying map (Fig. I) of a portion of the lake shows the location of different parts of the apparatus. At A, fastened to a wall built at the water's edge and facing down the lake, a board about two feet square was located. This board was divided horizontally and the

[1] An experiment on Earth Curvature. *Nat. Geog. Mag.* XVIII, p. 771, Dec., 1907.

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upper portion was blackened. The line, the junction of the light and dark surfaces, was made horizontal by placing both ends at the same distance above the water surface. A note was made of this height. At B, on a bar extending into the lake from the headland, the second portion of the apparatus was erected. This consisted of a white rod, one inch in diameter, mounted on an ordinary chart stand (Fig. II). Suspended from the rod was a cardboard scale. This scale was seven inches by ten inches and was covered with alternating black and white bands, parallel to the rod, each band one inch wide. The top of the first black band was one inch below the middle of the rod. By driving the legs of the stand into the sand, a steady location was assured. The middle of the rod was placed at the same height above the water as the horizontal line of the board at A. It was hoped that the line of the two pieces of apparatus would be projected on the bar of island M, as this location would make B a central location

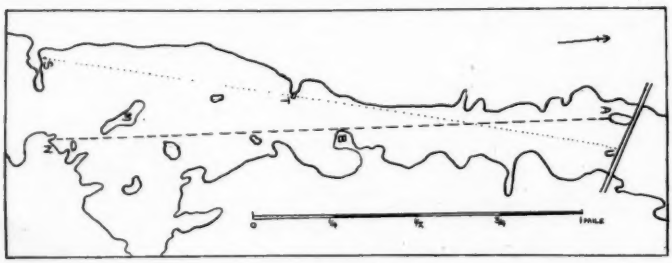

FIG. 1.

between A and the telescope. The bar was found to be impossible as great steadiness was required in order to read the scale at B. The third location was finally taken on a wharf at N. The telescope, an ordinary field glass magnifying about twenty-five diameters, was suspended by straps from a railing on the wharf. The axial point of the telescope at the place of suspension was fixed at the same height as the horizontal line at A and the middle of the rod at B. In sighting on the horizontal line at A, the white rod at B appeared in the field of vision projected against the top of the board. Inasmuch as the line on the board, the rod and the telescope were equidistant above the surface of still water, and the accuracy of their positions was guaranteed by repeated measurements, the result indicated that the water surface was not a horizon. The scale suspended from the rod was visible and the reading of this scale gave the departure of the rod from a straight line (Fig. III). The distance of the rod above the line from the

telescope to the line on the board was read. It was five inches and something more. The estimation of a fractional part of the inch was possible, but the limit of the field of visibility for the inch was being approached. The fractional reading was not sure enough, even after a number of readings, to be satisfactory. The distance was recorded as five and one-fourth inches. A check was made on this record. The rod appeared through the

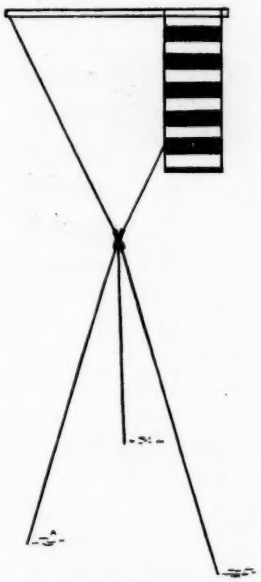

FIG. 2.

telescope at the top of the board. The width (vertical) of the board was read on the scale. The black band on the board was 10½ inches wide, and the white band was 11½ inches wide. The 21-44 part of the portion of the scale covering the board, read from the top down, yielded 5¼ inches. The distance from A to B was found to be 4,000 feet, from B to N, 4,500. In a simple reduction of the 5.25 inches to suit a position halfway between A and N, 4,250 from each, 4.96 was obtained. The letters which follow refer to Fig. IV. The use of the data and the explanation of the final reduction is shown, in part, by the figure. ADF is the line of sight; BD, the position of the rod; BM, the diameter of the earth. AB and BD are known, 4,250 feet and 4.96 inches respectively. The triangles ABD and

ABM are similar. A proportion growing out of a law of similar triangles is possible, namely,

BD:AB::AB:BM, or substituting for the numbers their values,

4.96 : 4250x12 :: 4250/5280 : x (the diameter)

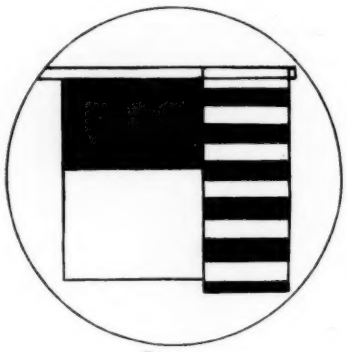

FIG. 3.

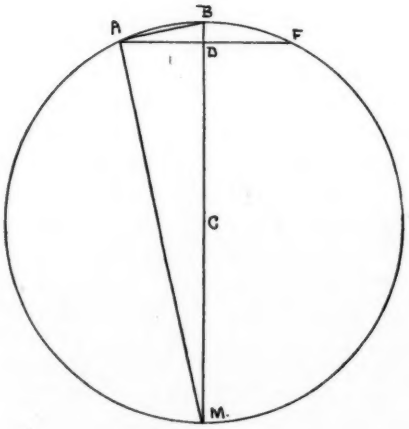

FIG. 4.

The terms of the first ratio have been reduced to inches, of the second to miles. This gives for the diameter of the earth 8,276 miles.

The result is an approximation. Many conditions enter into the experiment and prevent accurate results. The apparatus is of crude workmanship, the readings are not delicate and atmospheric refraction is a factor in the projection and readings. Other results, from other readings and with similar reductions ranged from 8,400 miles to 7,894 miles.

The writer believes that the experiment may be performed on any moderately level tract of land. The letters in the following discussion refer to Fig. V. Let a surveyor's leveling instrument be set at A. At a certain convenient distance, one-half mile, on opposite sides of A, erect stakes. By means of the instrument make them of the same height so that the line across the top of the stakes passing through the instrument will be a chord of a circle which is for all purposes the circumference of the earth. Transfer the instrument from A to B, a position on the opposite side of D at a distance equal to AD. Erect a third stake at E, at a distance from B

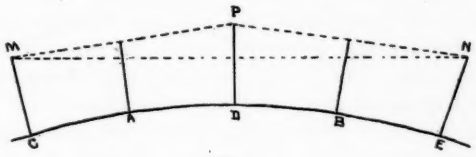

FIG. 5.

equal to BD and in line with A and D. By means of the instrument make its height equal to that of DP. The line PN will be another chord, and M, P and N will be points in the arc of the circumference. A sighting from M to N may be taken and the amount by which P departs from the straight line is a function of the curvature. The reduction of the data is by the process which was employed in the explanation of the experiment on Lake Quinsigamond. An approximate measurement of the size of the earth is obtainable by the problem of Eratosthenes.[1] The writer, in a note in THE JOURNAL OF GEOGRAPHY,[2] reported the result of such an experiment. This was performed by a class in the New Bedford, Massachusetts, High School; the co-operating station at Roxbury, Massachusetts, was in charge of Mr. I. H. Upton of the Roxbury High School. In this case the apparatus at each station consisted of a vertical stake casting a shadow upon a horizontal surface. It is necessary to have the two stations along the same meridian. The length of the stake and the length of the shadow at noon, local time,

[1] For fuller explanation see W. M. Davis, Physical Geography, 386.

[2] JOURNAL OF GEOGRAPHY, Vol. V, 187, 1906. For sun declination read sun's zenith distance.

on some appointed day are the data required from each station. In the right triangle formed by the stake, its shadow and the sun's ray just over the top of the stake, one of the complementary angles represents the altitude of the sun, the other its zenith distance. The difference of the zenith distances for the two stations is the number of degrees of arc along the circumference between the two stations. If the distance between the stations is known, the following proportion is solvable.

Number of degrees of arc : 360 :: number of miles between stations : x (the circumference).

In the instance cited, 25,046 was obtained.

Of the three methods, the writer believes that the first is the most effective. The experiment is performed under the simplest conditions possible by a process which is familiar to most pupils almost from the beginning of their geography study. It has a personal factor which is of value. The second might seem to fall into the same class, but the horizons of the instruments in the two positions, A and B, (Fig. V) to pupils unfamiliar with the leveling instrument, as they must be to a large degree at this stage, savors of arbitrariness. They can be convinced, but the strange element detracts from the simplicity of the experiment and acts as a slight barrier to the mental progress. The method of Eratosthenes has the same conditions to contend, namely, abstraction which lessens the force of the experiment. In the discussion the pupils had a tendency to speak of it in an impersonal light, as something not wholly within their experience.

A NEW COURSE IN GEOGRAPHY AT THE TEACHERS' SCHOOL OF SCIENCE, BOSTON, MASS.—The Teachers' School of Science at the Boston Society of Natural History has recently added instruction in geography to the courses previously given in botany, zoology and geology. The course, under the instruction of Professor D. W. Johnson of Harvard University, will consider the following topics each for a year: The Geography of the Lands; Economic Geography; Geography of the United States and Geography of Europe. Each year's work consists of classroom and laboratory exercises for 30 hours, at the close of which a certificate will be given to those who have done satisfactory work. The new department has enrolled 156 members, practically all Boston school teachers.

STEREOSCOPES IN SCHOOL

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PROVIDED that the work is intensive, I am persuaded that the stereoscope is the most promising help in geography work that is in sight. But intensive work means class work, and class work with the stereoscope demands that we have as many stereoscopes and as many copies of each picture as there are pupils in the class. To do this effectively we must have cheaper pictures than are offered by the commercial houses.

I have been making and buying photographs to illustrate foreign and home scenes since 1884, when I was in South America. The pictures thus gathered in South America, in Europe, in the West Indies and in various parts of this country have served as a most valued reminiscence of old days and distant lands. Some of them have been used to illustrate papers in this JOURNAL and similar publications. But all of us know how imperfect such illustrations are. Not merely because the reader is not always sufficiently trained in observation to make out the meaning of the picture, but the thing we have sought to represent is not always visible in the picture to those who have not seen the spot.

What we make out of a picture is in part contributed by the picture and in probably greater part supplied by the mind of the looker. Artist Kelly tells us in the introduction to his volume of marvellous colored pictures of Egypt that the Fellahin looked over his shoulder while he was at work and saw no meaning in his painting, no suggestion of the scene before them. Any picture is interpreted by the mind of the spectator as much as spoken words are by the mind of the hearer.

How common our experience of knowing a scene well in pictures and coming to it in reality with complete surprise! Who can be prepared by pictures for Niagara, or the Grand Canyon, or the Alps so adequately that he will not find the reality quite different from his expectation? Even less splendid scenes than these, which may not arouse any sense of awe or sublimity, that might be thought too subtle for expression in the picture, will be found on examination to fail of adequate representation in monocular view. It is worth while to state the fact that all our picture records of fact are made as seen with only one eye, though we look at them complaisantly with both as if they were suitable for natural vision. Under this limitation of monocular vision photographs have their best use as a reminiscence of scenes that we already know. In such use the memory supplies the necessary elements for interpretation.

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Book illustrations have made extraordinary improvement since Egloffstein's dreams of the Grand Canyon were published as real pictures in the report of the Ives' Expedition, yet there is a general sense of disappointment as to the results of their use. For one thing they are small. I do not wish to be understood as belittling illustrations, but I do feel strongly that they make singularly little impression on students. Good students will read a lesson and keep their eyes closed to illustrations designed to make the matter clear and well designed. A teacher who has become familiar with the main dogmas of physical geography in the field as well as in the school room can not fail to delight in the unrivalled series of illustrations that adorn Tarr's New Physical Geography (1904). It is far from certain however that students get the help they ought to from them. Even if the teacher insist by picture questions on bringing every picture into the recitation, the work is difficult as all who have tried it with young people will testify. It goes so hard that a teacher with little time and many subjects is sorely tempted to relax the needed insistence. The men who make the pictures are likely to miss this fact. Any picture that I have made from a scene that I have visited is so clear to me that I am but human to regard it as superior to all previous illustrations, yet the greatest element in this superiority is, I think, in our knowledge of the place and the interpretation that our minds are therefore able to give to the picture. For the stranger to the scene the greatest defect of the scene is that it was made with a camera with but one eye. If there is any unvisited scene in your neighborhood that is admired take your first look at it with a long, loving gaze with one eye strictly and continuously closed! Visit Switzerland with one eye always under a bandage! Absurd as this is it is just what we have always done in our picture-making. To be consistent we should always bandage one eye before looking at the pictures!

There has been a good deal of collecting pictures by teachers with the very doubtful results noted by Mr. Emerson in the September JOURNAL. I have a good many colored photographs obtained from the Detroit Photographic Company, beautiful pictures if they are one-eyed. But after re-repeated efforts to use them I admit that the only ones that do get really adequate use are the four or five large ones that hang on the walls, where I can direct class attention for definite information at the moment it is wanted. With these pictures, big enough to be seen at a distance and ever ready for use, it is surprising how many good occasions arise. A large and costly Jungfrau that hangs on my class-room wall is probably the most profitable investment in our geographical outfit. Plainly, however, one cannot have many large wall photographs. Country schools can perhaps

never have any. All my attempts with the smaller photographs bring me to the same result: they are needed in multiple copies to make their use effective, and they are too dear to obtain in this way. It is true that pictures are of some use just left around where pupils will glance at them. They are of some use in the magazines and books that come more or less into pupils' hands out of school. But that sort of thing must not be confounded with *teaching* by pictures. Like other laboratory work it requires a definite period, definite direction and this direction by the living teacher, while the view is being examined in the presence of a class of persons similarly occupied leads to discussions and explanations that will not occur with individuals looking at pictures even under the stimulus of printed directions.

Last spring my attention was called to the stereoscope, first by one of my colleagues and then by the agent of a commercial house. I had not used one for many years and it was a revelation of new possibilities. Here, for instance, are admirable views of plains from the edge of a cliff, a thing the monocular camera cannot touch. Here are distant mountains, perfectly shown at the horizon, a thing that every amateur has bemoaned as impossible to his camera. Here hill and mountain stand up in their true strength and majesty instead of flattening down to insignificance. Everyone knows that photographs do not tell the truth about slopes. Old artists exaggerated them outrageously in steepness, but the one-eyed camera's flattening is almost as untrue. Here is the nearest thing possible to a reproduction of the real world of a race of two-eyed men. With the stereoscope there is impressed on the mind no inconsiderable part of the majesty of grand scenery. Stereographs may really build up new concepts in the mind and not serve merely for a reminiscence.

But we must have duplicate copies. These scenes should be studied and studied intensively. Alone the pupil will no more know how to look at them than he will know how to go out and do his field work alone. It is the experience with large scale maps over again. The United States topographic map is a superb collection of physiographic forms, but students have to be taught to use it. They must learn to read it, and the reading exercise should be an exercise in class. I did a good deal of experimenting on that in the Brockton High School with classes of one hundred and twenty, heard in sections of thirty, with maps enough for all to get at them directly. The maps were quickly read and became the best piece of apparatus of instruction. It may be remarked that the reduplication of copies was only made possible in this case by the low price of two and later three cents a sheet that the national government puts on the map. Had we been left to commercial houses for our supply it would not be possible.

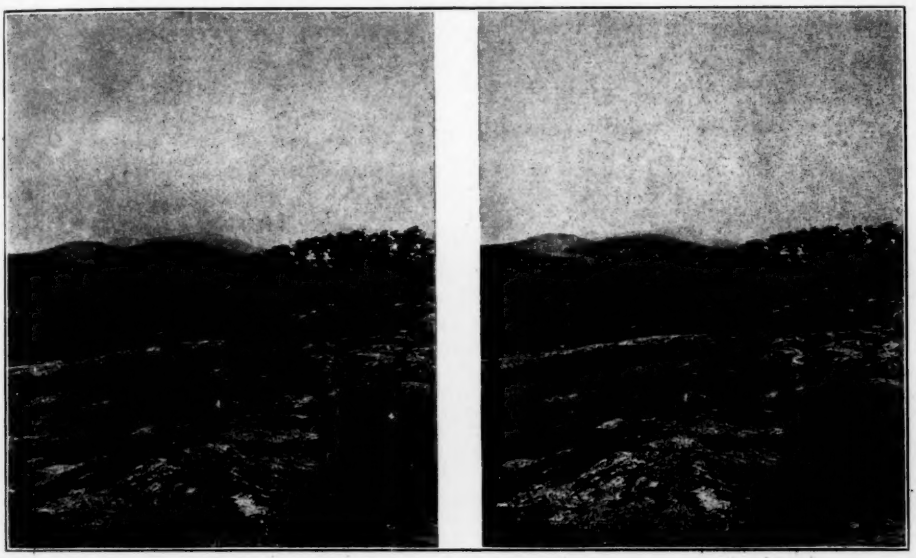
That multiple copies of the topographic map are used by many teachers I know, for a list of type-written exercises that I prepared was so often called for and so often lost that I had to get it printed a year ago, and other series of similar exercises are familiar to JOURNAL readers.

At first it seemed to me so hopeless to afford a class outfit of stereoscopes and views that I hesitated. Later I bought from a large supply house six instruments and six copies of each of 16 or 17 views at a cost of about $20. I had a small class with whom the experiment might be tried. It was an instant success. Now the outfit has been increased to twelve in a set. Later I shall hope to make it thirty-five, supplying the largest of our working sections. The more I use the pictures the better satisfied I become with a few pictures for the whole class rather than a larger collection of single views to be used in various extensive ways. Definite questions are asked. All have note books and write down the answers to two or three questions. Then we have some answers read and discussed by the class. On some pictures we spend forty minutes; others are fairly seen in ten or fifteen. It should be remembered that only a few selected views are used and they should be selected with much content of material. The selection is not of course easy. The pictures have been taken from a scenic rather than a geographic point of view. Many of the forms needed in geography classes have not been taken at all by the commercial stereograph maker, their photographers are not even aware of the existence of them. Also there is necessarily always trouble in buying pictures from a catalogue.

Being among the old mountains of south central New Hampshire this summer I bought a stereoscopic camera of the Eastman's—it costs but twelve dollars—and made some pictures I had long come to regard as unmakeable. For old mountains are low and mild of form to such a degree that they flatten beyond recognition in a monocular camera. Stereoscopic pictures are easier to take, too, than other photographs, for where all relief is dependent on light and shade a good picture demands very careful choice of time and position to catch the shadows where they have the best effect. But the stereoscope has another and more effective method of showing relief so that light and shade may be regarded as important but subordinate matters. Stereoscopic pictures taken in rain or under a clouded sky may yet show better relief and solidity than the best monocular picture in the sunlight.

The pictures one gets with the stereoscopic camera are very beautiful and much more satisfactory for any geographic use than other pictures can be. The boulder clays of New Hampshire have a very peculiar foliation with sandy partings which I have tried unsuccessfully to photograph with

three different cameras, and I have knowledge that others, too, have made the attempt. The stereo camera gave a good picture at once. Shallow grooves and low hills, gentle slopes and irregular dumps below landslips, all reappear in the stereoscope almost as they stand there in the New Hampshire air. A friend at Yale told me this summer he had never seen a good photograph of a kettle hole, nor had I, but I tried with the stereo camera and got two good ones at once.



The work is not expensive. I have twenty-nine dozen views I have had made from my negatives, and even counting in the camera and developing tank and all materials the prints have not cost much over a dollar a dozen. My own time went into the work of taking the pictures and developing them without charge, but the printing has been done by a professional. Of course the list of subjects is limited, and although it contains pictures that cannot be bought anywhere it does not contain any of the wonders of the world. If other readers of the JOURNAL who are interested in photography would try this sort of thing perhaps the Editor would allow us to exchange material with the help of his pages as long as our objects

are educational and not commercial. The ideal thing from the point of view of cheapness is a mechanical reproduction. The half tone that accompanies this paper has been made from one of my negatives as an experiment. The cost of making would allow its sale in quantities well under a cent a copy. A finer mesh to the net would give better results, and the next experiment will try that. It should be put in the stereoscope to be judged. It shows a typical hill top 1,300 feet above the sea in New Hampshire, rounded, smoothed and weathered, with the grass growing in the crevices, the trees crouching in the hollows on the right (east) and the round summits of the higher Belknaps ten miles away to the northward. A great groove cuts across the ledge shown in the foreground as the stereoscope plainly reveals, though it is not visible without. Fragments of rock, mostly like the ledge strew the ground, suggesting the source of the stonewall that crosses the ridge just back of the trees. The grey tone of the rock in the print is close to nature. It is a characteristic view of a stony New England hill top, good only for thin tree growth and sheep pasturage, but beautiful to walk along with whole counties spread out to right and left.

I am indebted to Dr. Lane of Lansing for calling my attention to the "Imperial" (address, "Rotograph," 101 Fifth Avenue, New York), a tiny folding stereoscope with twenty-five views, all for twenty-five cents! Of course it is a toy; the views are not geographical, but they show possibilities. It is evidently only necessary for teachers to demand it to have some appliance of the sort made at a price that will allow its use even in country schools. If those were the right twenty-five pictures there is an individual outfit for a class of ten for $2.50. The large market that public schools afford should make an even better article possible at that price.

I may note that the dealers in stereoscopic views decline to interest themselves in cheap reproductions. Reasons stated are that "There is no demand," "We fear we should have to reproduce our whole stock."

EDITORIAL

RELICS OF THE PAST IN SCHOOL GEOGRAPHY

For generations school texts in geography have largely been written according to one scheme, and school geographies have been, as a rule, merely formal epitomes of larger volumes which summarized the existing knowledge of geography according to a uniform plan. Because the adult investigator or author approached the subject from the causal side and treated the causes before considering the life consequences, children were called upon always to approach the subject in the same way. The results of such a plan are well known.

Within recent years there has been a change in the general scheme of our text-books. The students of modern education and the scientific geographers have recognized that the best training could only be secured when the study of geography was fitted to the needs and abilities of the pupils. Hence the introduction of Home Geography and the plan of proceeding from consequences to causes in the intermediate grades, thereby overturning the time-honored method of procedure with great benefit to all concerned. We have proved by experience that children can get better training in geography and in the methods of scientific reasoning, waste less energy, and that their work is in every way more effective in geography provided the causal relations are worked out as carefully when proceeding from consequences to causes as from causes to consequences.

In our enthusiasm over a new and promising plan the temptation is, however, to go too far and perhaps to follow the consequence to causal order, the analytical order, to extremes. We are in danger of making this plan as hackneyed and, in the course of time, as inefficient as the old plan of cause to consequence, except in those rare instances where the work is conducted by a masterful teacher who is a master of geography.

We hear much of training children for life in both the elementary and secondary schools. We are not training future geographers in the elementary school, but we are trying to prepare our pupils so that they will be best able to use their powers and knowledge in the outer world of life. We teachers of geography believe in the value of our subject as one of the essential elements in the education of any person. Our pupils are going out into an adult and not a child's world. So far as geography is concerned these future citizens will, in their reading and study, find the subject presented to them in encyclopedias, reference volumes, advanced texts, books of travel (except when written by an ungeographic globe trotter, perhaps), from the

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adult point of view, largely. The procedure will be from causes to consequences, from the simple to the complex, in a definite, scientific sequence. If our pupils are to be able to gain more knowledge, more help and pleasure from the further study or reading of rational geography, then we must see that they have had some study of the simpler cause to consequence plan of presentation before they leave their school work. We can not train children to be adults unless we give them some training in the adult method of work, and some experience in studying the kind of materials they are to find in general use later; children in the later years of the grammar school can study geography from causes to consequences and find pleasure and profit in definite work of this kind.

In our attempts to get away from the old formal plan in the earlier grades, in our endeavor to react against the over-emphasis of the physical side in geography, blinded perhaps by success with a new plan and by the alluring sound of ontography or ecology as we were by physiography, let us not allow the pendulum to swing too far to one side. Although life responses to the physical environment will, in the course of time, be organized as definitely, perhaps, as are the elements in the physical environment itself, and though the books of the future will be stronger and better because of this better organization of the life and man side, the scientific and accurate geographic volumes for adults must still be written in such an order that causes precede consequences. The stage on which the play of life has its setting must always be viewed as a background to the incidents of life itself, whether it be individual or national life.

Let us be careful, therefore, that we give our pupils in school such a course of study in geography that we make them able to go farther in geography in their daily life in an adult world. While we avoid the errors of the past, let us not fall into new errors which, chosen from an incomplete view-point of the ends desired will probably prove as dangerous as were the methods of our less well trained predecessors in educational work.

A MINIMUM MAP EQUIPMENT

Numerous inquiries as to map equipment for schools suggests again that this side of our school geography work is neglected. Every class room ought to contain at least a map of the United States, one of each continent to be studied in the grade and a map of the world. Less than this is more than inadequate. At least this number is essential for decent work in geography, history and current events.

NOTES

SUGGESTIVE OUTLINE IN GEOGRAPHY FOR THE SIXTH, SEVENTH AND EIGHTH GRADES OF THE SCHOOLS OF MICHIGAN.[1]—The point of view and emphasis in these grades changes to another phase of geography. In the previous grades the work was largely observational and descriptive in character, because the observational and imaginative activities of the child were then dominant. The pupils have been growing older, other mental activities have been coming forward which make it not only possible but necessary that the rational side of the subject shall be introduced more and more as the work progresses. By rational geography is meant the study of the subject matter from the point of view of cause and effect. In the study of the Sahara desert, for example, the arid conditions should not only be described, but they should be traced backward to their causes and forward to their effects on the life, habits, dress, and occupations of the people. The culminating interest in geography centers in the life of man, his occupations, his commerce and manner of living. Almost any one of these topics, if traced backward to its causes and determining conditions, soon ends in certain conditions of his physical environment. To understand life on the earth we must first know and understand the physical environment of that life.

At the beginning of the sixth grade, when the second or advanced book is usually taken up, it is recommended that a more detailed study of the physical factors and forces of geography be made than has heretofore been possible. The attention given to this side of geography in the previous grades has been more to the securing of good, clear mental pictures of physical features and the acquisition of facts than to the explanation of those features and facts. In this second study of physical environment, emphasize the processes concerned and the forces at work in producing that environment.

PHYSICAL GEOGRAPHY.—In most texts used this work will include the following topics:

1. *Shape and size of the earth.*

   Some proofs of the earth's shape may now be given with hopes of their being understood. Sailing around the earth and the appearance of ships at sea, as usually stated, prove only curvature. State them so they prove equal curvature in all directions.

[1] From Bulletin No. 22. Prepared by Professor R. D. Calkins, Mount Pleasant, Mich., and published by the State Superintendent of Public Instruction, 1907.

Even here these proofs mean very little unless they can be actually experienced. Let the child see that the size of the earth is an important factor; that because of its size, and its great barriers of oceans and mountains, the people of the earth have been separated and isolated from each other; and that because of this separation and isolation there have arisen differences of language, customs, manners, and race. Latitude and longitude are measured in degrees and not miles, because the earth is curved. As we move north or south over the earth, new stars rise above or sink below our horizon and from their change of position we are able to find our latitude.

2. *Motions of the earth.*

a. Directions as a result of rotation. Re-emphasize this fact that it is rotation which makes the finding of direction possible. Various methods of finding the north pole star and Great Dipper; shadow at noon; point the hour hand of a watch toward the sun, then half way between the hour hand and the figure twelve on the dial will be south; the compass points towards the north magnetic pole and not towards the true north pole. It does not always point north therefore, but in Michigan it varies but little from true north.

b. Longitude and time—standard time, international date.

Show how a spherical earth rotating causes the sun to rise and set and cross the various meridians at different times, and how, by knowing this difference of time between places, we can find difference of longitude. Emphasize the fact that because the earth is spherical and rotates from west to east, sunrise, noon, sunset, midnight, and with it the new day, all come from the east, that New York has sunrise, noon, sunset, and the new day before Detroit, and that the new day begins at the 180th meridian or the international date line and travels around the world to the west ending again at the date line when midnight reaches it. All of this, together with the length of the day, is a consequence of rotation.

c. Seasons.

In the third grade the pupils learned from observation that summer is warmer than winter because its days are longer, its nights shorter, and the sun's rays are steeper. The explanation of why the days are longer and the sun's

rays steeper in summer than in winter is too difficult to be attempted until now. It is believed that in connection with the motions of the earth it can now be shown why this is so and why we thus have change of seasons.

3. *The atmosphere.*

a. Its composition, pressure, etc.

b. Water vapor. How it gets into the atmosphere and the conditions governing the rate of evaporation; how it gets out of the atmosphere and the various forms into which it condenses —fog, clouds, dew, frost, rain, snow, hail.

A common error in teaching the relation of mountains to rainfall is here to be guarded against. The usual statement is that the wind blows against the cold side of the mountains, is cooled, and its moisture condensed into rain or snow. If this were the cause the vapor would gather from the atmosphere upon the cold rocks as dew or frost and there would be no rainfall.

Whenever a gas is compressed it is heated as one may see by noticing how quickly a bicycle pump becomes heated in pumping up the tires. When the pressure upon a gas is suddenly decreased it expands and becomes cool, as all know who have noticed how cool the air is as it escapes from the valve in a bicycle tire. Now, when air moves up a mountain slope it is rising into regions with less air pressure. As the pressure upon the rising air decreases it expands and cools just as does the escaping air from the bicycle-tires. It is this cooling which causes the condensation into rain or snow. It is called cooling by expansion and is the chief cause of the cooling which produces rainfall everywhere.

c. Air temperatures.

(1). How distribution of temperatures over the earth is represented on a map by isothermal lines.

(2). Causes of unequal temperatures between the equator and the poles.

(3). Causes of unequal heating of sea and land. CAUTION—The high temperatures of Western Europe and Western North America are due more to the unequal heating of sea and land than to the Gulf Stream and other currents. In winter the ocean is warmer than the land and would be were there no ocean currents. Winds blowing from the west carry these moderating temperatures to the west coast of Europe. If the prevailing winds blew

from the east the British Isles and New Foundland would exchange climates. Put the emphasis upon unequal heating of land and sea and the prevailing winds rather than upon ocean currents.

d. Winds.

(1) How unequal heating of the air causes it to circulate and winds to blow.

(2) Teach thoroughly the location, direction of wind, and other characteristics of the following wind and calm belts.

(a) The trade winds.
(b) The doldrum belt.
(c) The horse latitude calm belts.
(d) The westerlies.

Constantly be on the lookout for conditions in the local weather which illustrate the types of weather found in these various regions.

(3) Show how migration of these belts causes wet and dry seasons—as in California and regions near the equator.

(4) Monsoons—due to unequal heating of land and sea in winter and summer.

(5) Land and sea breezes due to unequal heating of sea and land by day and night.

(6) Cyclonic storms and how they control weather in the temperate zones.

e. Weather.

It is time that the schools do something to destroy the superstition and ignorance that prevails as to the cause of weather and weather changes. The moon does not control weather, there is no equinoctial storm, and no one can at present foretell weather accurately a year, or even a month, in advance. Teachers should look up this topic and be able to explain the weather changes as they occur. Write to the nearest weather bureau station and ask that the daily weather map may be sent to your school.

4. *The ocean and ocean movements.*

The oceans, their extent, depth, nature of their bottoms, wind waves, tides, and the chief ocean currents. The relation of wind to waves and to ocean currents should here be brought out. Show

also how the currents generated by the winds are deflected by the continents into their present courses.

5. *Rain and river erosion and land forms.*

Teach by observation in the neighboring fields how the water running off after a storm erodes gullies in the hillsides, how these gullies grow wider, deeper, and longer with each storm until they are finally cut to the depth at which water stands in the ground when they thus acquire permanent streams. Show by example if possible how these valleys at first are narrow and V-shaped, often with falls or rapids and lakes in their courses; how in this condition they are said to be young valleys, how the side wash on their sides and the streams in their bottoms destroy the falls, fill up and drain the lakes and, swinging from side to side, cutting on the outside of each curve and depositing on the inside, gradually widen the valley bottom forming flood plains, the valley thus passing into maturity and old age. Take up the other erosional forms of the text and the neighborhood and give the pupils as clear conceptions as possible of how the weathering and erosive forces sculpture the surface of the land into all its varieties of form.

6. *Glaciers and glaciation.*

Introduce them to the mountain and valley types of glaciers now existing in many regions, showing the various phases of erosional work of these glaciers, how they smooth, polish and striate the rocks over which they pass and how they form moraines along and across their valleys. Now search the clay bank along streams, the excavations for cellars, and ditches, to find rocks in the home region which have been smoothed, polished and striated by glacial erosion, thus proving that their region was once beneath an immense ice sheet which brought and distributed over this region the thick deposits of drift upon which they live. In this or in a later grade, when the United States is studied more intensively and in greater detail, give them some idea of how the Great Lakes and the thousands of smaller lakes in northern United States were produced as a result of this glaciation, thus bringing out the relation of the effects of glaciation to man.

7. *Coast lines and the various forces and agents at work in changing them.*

OUTLINE FOR CONTINENTAL STUDY.—In these upper grammar grades each of the continents should be studied once as a whole, the aim being to

bring out the causal relations existing between the various topics in the following outline. Much of the information may be acquired from globe and maps. The outline serves also for the study of countries.

1. *Position.*
   a. In relation to other continents and great commercial nations.
   b. In relation to oceans.
   c. In latitude and longitude.
   d. In relation to prevailing winds.
   e. What does position tell us of the climate of a continent?
2. *Form.*
   a. General form—memory maps drawn to impress general form.
   b. Detailed form or coast line—regular or irregular, low, flat, sandy or marshy, high, steep or rocky. Was coast formed by rising or sinking of the land in relation to the sea level? Chief indentations, peninsulas,—continental shelf, how formed, where wide, where narrow—effect of an elevation of 600 feet upon land area—of a submergence of 600 feet—relation of coast line to commerce and life of the people.
3. *Size.*
   a. As compared with other continents, estimated from globe.
   b. Greatest length, width, and other distances, measured from map by use of scale.
   c. Time necessary to journey in various directions across continent, traveling at varying rates. Give this as problems to be solved.
   d. How many times the size of the United States? Of Michigan?

   Given as problems from data supplied by teacher.
4. *Surface* (data to be secured largely from map).
   a. Primary or main highland.
      (1) Its name, location, continent, and trend.
      (2) Average length, width, height, and slopes.
      (3) Mountains traversing highland, their names, trend, height, chief passes through the mountains, and general characteristics.
   b. Secondary highland.

      Same as for primary.
   c. Lowlands.

      Names, location in continent and in relation to highlands

and mountains, extent, slopes, and any distinguishing characteristic features.

d. Drainage.

Have pupils trace divides—note slopes from these divides down to sea level, long slopes, short slopes, length of streams in relation to slopes, chief rivers, age of valley, mouths of streams, deltas at mouths or estuaries due to submergence.

e. Relation of surface to life of people.

Relation to occupations. Do mountains act as barriers isolating the people or is communication easy? Relation of mountains and other physical barriers to political boundaries, size of states, etc.

5. *Climate.*

a. Temperature.

(1) As determined by angle of sun's rays or latitude.

(2) As modified by elevation.

(3) As influenced by winds from ocean.

(4) As shown on isothermal map.

b. Prevailing winds, and any modifications due to monsoon influence, as in Asia and India, for example.

c. Rainfall.

(1) Regions of heavy and moderate rainfall. Why?

(2) Arid regions. Why?

(3) Seasonal occurrence of rainfall. When? Why?

6. *Vegetation.*

a. Factors influencing temperature, rainfall, soil.

b. Characteristics of vegetation in hot moist regions, e. g., the tropical rainy forest.

c. Changes in the above with decrease of rainfall.

d. Characteristics of vegetation in hot arid regions.

e. Effect of cold temperatures upon vegetation in humid and in arid regions.

f. Distribution and characteristics of vegetation of the continent as controlled by the above condition. The forest regions, chief trees, the savannas and prairies, deserts.

7. *Occupations.*

a. Occupations in forest regions, lumbering, gathering of forest products.

b. Grazing and herding regions.

c. Agriculture, with and without irrigation. Location of the

industry, its limiting conditions, chief products, etc. Note how climate influences and controls this occupation.

d. Mining and mineral resources.

Why are mountains more commonly mining regions than plains?

Note well the location of the coal and iron mining regions, for when both of these are found in a region manufacturing is usually an important industry.

e. Manufacturing.

(1) Conditions determining location of manufacturing regions.

(a) Power—coal, water, electricity.

(b) Raw material for manufacturing.

(c) Food supply.

(d) Commercial facilities for bringing raw material, power and food supply together or disposing of manufactured products.

(e) Labor and capital.

(2) Location of manufacturing centers or regions and chief products of each.

f. Commerce.

Commerce grows out of needs and wants of the people which in turn largely grow out of occupations.

(1) Needs and wants of manufacturing section and what they have to supply.

(2) Needs and wants of various agricultural sections and what they have to supply.

(3) Similarly for mining regions, grazing sections, etc.

(4) Movement of goods and products to satisfy the above needs and wants.

(5) Means of transportation—navigable rivers, canals, and railroads.

(6) Commerce with other continents and regions as an outgrowth of diverse needs and wants growing out of differences in occupations and natural resources.

8. *Location of cities.*

a. Manufacturing type, like Pittsburg, and conditions favorable to growth of such cities.

b. Commercial centers like New York and Liverpool, and conditions favorable to their growth.

c. Governmental types of cities, like Washington and Lansing.

d. Educational centers.

e. Combination of two or more of above types like Chicago, which is commercial in origin and growth but because of meeting of commercial routes, nearness of coal, etc., is a great manufacturing center.

9. *Population.*

Distribution of—where dense, where sparse, as determined by occupations and food producing capacity of the various sections.

INTENSIVE STUDY OF A REGION.—After a continent or a large country like the United States has been studied, as called for in the outline for continental study, and the pupils know in this way the general relations of the various geographic districts to each other and to the whole, they are then in a position to take up the intensive study of these various districts and individual countries.

It should be the aim of the teacher in these upper grammar grades to give the child a higher conception of what geography is than he has been able to obtain in the previous grades. It was the aim of those grades to give mental pictures of distant countries and regions and to lay a foundation of well-understood facts. It is still the aim to broaden the pictures and increase the number of facts, but, in addition, to bring out and make clear those relations existing between the life of a given region and the physical environment of that life, to show, as far as possible

1. What the physical conditions of the region or country are and how they came to be.

2. How these physical conditions have influenced the life, industries and history of the people of that region.

3. To emphasize those peculiar things for which that country stands, industrially, commercially, and socially.

Thus, for example, after the United States has been studied as a whole so that the child knows in a general way the more important features of its surface, climate, vegetation, after he knows where the mining, manufacturing, agricultural, and grazing regions are located and how these regions largely supply each other's needs and wants through the domestic commerce of the country, then he can understandingly take up the intensive study of the New England states and have impressed upon him just what it is in this region and its people that has set it off, not in isolation, but in the character of its industries, institutions, and history from the other sections of the country.

Let him see first of all those stony New England hilltops rising to

approximately the same elevations and separated from each other by rather steep-sided narrow valleys and, mantling over all, that coarse stony soil which has ever been the bane of successful agriculture. Make clear to him the rocky many-harbored coast of Maine, the long sandy front of Cape Cod, and the branching arms of Narragansett Bay. Now give these facts perspective and fix them forever in his mind by teaching how they came to be. Let him know that for ages New England was worn by rain-wash and streams until its surface had been reduced to almost a plain (a peneplain). Then came the uplift of this plain, the streams cutting the present valleys and forming the even topped hills. Then came that great ice sheet which covered the region, accumulating along its front a terminal moraine of which Long Island, Martha's Vineyard, and Cape Cod are in part remnants. The old, probably rich, soil was swept away and in its place was substituted the present coarse, rocky, sandy mantle which banished all hopes of agricultural greatness from the region. This mantle of drift, when the ice had melted away, dammed the old valleys, forming basins where now we have the thousands of New England lakes, sent the streams coursing over new channels, tumbling here and there over precipices or rushing in rapids down steep slopes, thus giving to New England its water power which forms the basis for its manufacturing. Show also how, by the submergence of the lower portion of its river valleys, its many harbors were produced with all the beneficial effects they have had upon its industries and history.

Then let him see how, with the landing of the Pilgrims, the white inhabitants entered upon a century of long struggle with the rigors of its climate and the hard conditions imposed everywhere; how the purpose of that struggle was to make the region give a livelihood to its constantly increasing population, and how it was finally attained, not in a greater number of acres of wilderness conquered and tilled, but in the evolution of one of the most diversified of industries. Many continued to struggle with the rocky soil. Others, influenced by the many favoring conditions, were tempted to enter the more profitable but more dangerous occupation of fishing. This led to commerce and both of these made a demand which created the shipbuilding industry. Manufacturing in the earliest day, typified by the spinning, weaving, and shoe making of the New England kitchen was transferred to the factory, and to-day New England produces 56.2% of all cotton goods manufactured in this country and 58.6% of all the boots and shoes.

Individual attempts to gain a living in colonial times, under the stress and competition of those days, are represented to-day by great factories

employing thousands of men and representing millions of invested capital.

When the pupils realize how physical conditions drove the people into a greatly diversified industry and how only by so doing could they live in the region, they are in a position to realize why the New England colonies resented England's attempt to tax those industries and their commerce out of existence and by that resentment brought on the Revolutionary War. In this way ought geography to correlate with history.

Let them understand, in considerable detail, these variously diversified but typical industries of New England as they are carried on to-day—the hard, dangerous life of the New England fisherman; the rush and roar of the New England factories and the remarkable manner in which certain industries have been localized in certain cities and sections; the quarrying industry of Massachusetts and Vermont, the paper pulp industry fed by the remaining forests of spruce; and the hard struggle which the New England farmer still carries on with the soil.

Something after the manner indicated above should the teacher, in the study of every region, aim to bring out those vital and fundamental relations of life to its environment which constitute the essence of modern geography. This intensive study of regions and countries should be based upon and grow out of the text's treatment of those regions. It will be necessary for both pupils and teacher to supplement the text with as wide reading from other sources as possible.

SCHEDULE OF WORK FOR SIXTH, SEVENTH AND EIGHTH GRADES.

In order that the study of geography in the seventh and eighth grades, when the pupils are most capable of understanding the geographic relations of things, may take on something of this intensive character and that this more thorough study may be made of the more important countries ending with that of their own country, it is here proposed that the usual order of the text be reversed and the less important continents and countries be studied in the sixth grade, leaving for the seventh and eighth grades Eurasia and North America.

Sixth Grade.

1. A study of the features and forces of man's physical environment as partially outlined above and as included in most advanced texts but supplemented by observation and field trips.
2. South America.
   a. Study of the continent as a whole as per outline for continental study—with special emphasis upon climatic control of occupations.
   b. Mapping of the continent upon meridian-parallel networks.

c. Topics for intensive study.

(1) Tropical rainy forest, their characteristics and relation to man.

(2) The pampas and llanos and the grazing industry of the continent.

(3) The nitrate industry of the Atacama desert.

(4) The rubber industry of the Amazon valley.

(5) The coffee industry of Brazil.

3. Africa.

a. The continent as a whole.

b. Mapping of the continent.

c. Egypt,—the Nile valley, life and occupation of the people, methods of irrigation, etc.

d. The Sahara—life and habits of man, animals and plants as conditioned by aridity or the presence of moisture in oases.

e. Life in the tropical rainy forests as compared with South America.

f. South Africa—sheep raising, ostrich farming, diamond mines, etc.

4. Australia.

a. The continent as a whole.

b. Mapping the continent.

c. Strange animals and plants.

d. Sheep raising industry.

e. Gold mining.

Seventh Grade.

1. Special observation work throughout the year upon the weathering of rocks and the origin of soils, rain and river erosion, and the land forms of the home region.

2. The continents of Europe and Asia as per outline.

3. Mapping of Europe and Asia.

4. Special study of China and Japan and the most important countries of Europe, especially Great Britain, Germany, France, and Russia.

Eighth Grade.

1. Special study of weather and weather changes. Secure daily weather map from nearest weather bureau station, Detroit or Grand Rapids.

2. North America as a whole with special attention to the interrelations of surface, climate, vegetation, and occupations.

3. Mapping of North America.

4. The United States. Give the greater part of the year to the most careful detailed and intensive study of our own country in all its geographic relations. Emphasize especially the characteristic physical features of such physiographic divisions as the New England plateau, Atlantic coastal plain, Appalachian mountains, etc., showing how each of the regions influences the life of its people and their occupations. Considerable attention should also be paid to our outlying territory, such as Alaska, Porto Rico and Hawaii. Map the United States upon meridian-parallel network.

CLIMATIC FEATURES OF FLORIDA.—Humboldt says the term "climate," in its broadest sense, implies all the changes in the atmosphere which sensibly affect one's physical condition. It is obvious, then, that the factors in the order of relative importance in the study of climate are: Temperature and relative humidity, or the moisture content of the air. Vital statistics show that longevity of the human race is greater in warm climates than in more rigorous latitudes—a concrete statement indicating that radical temperature changes are conditions adverse to long life.

Temperature.—Although covering a range of 6° in latitude the climate of Florida is generally uniform and, in view of the proximity of large bodies of water, may be termed oceanic. Abnormalities, however, do occur and with favorable pressure the isotherm of freezing weather dips far down the peninsula, and under the most extreme conditions freezing temperatures are limited only by the confines of the mainland. There are some fragmentary, though authentic temperature records previous to 1835. The data are sufficient, however, to show that the history of the severest freezes was recorded with considerable accuracy. About the earliest period at which reference is made to very cold weather in Florida was in January, 1766, when fruit trees were killed in St. Augustine. In 1774, according to Major G. R. Fairbanks, Florida historian, a snowstorm extended over a large portion of the State, the occasion being referred to by the inhabitants as "an extraordinary white rain." In 1799 the temperature was sufficiently low on April 6 to kill vegetation over the north half of the State. It is generally accepted, however, that the coldest weather ever experienced, so far as authentic records go, was on the 7th of February, 1835, when the temperature in Jacksonville was 7° above zero. The St. Johns river was frozen several rods from the shore and all fruit trees were killed. Subsequently, the following abnormally low temperatures occurred in that city during the years indicated: 1857, 16°; 1868 20°; 1870, 19°; 1880, 19° on December 30; 1886 15° on January 12; 1894, 14° on December 29; 1895, 14° on February 8; 1899 10° on February 13;

and 1900, 18° on February 18; records previous to September, 1871, are unofficial. The cold waves in 1886 and 1894, 1895, 1899 and 1900 were very destructive to fruits and vegetables. In 1886 and 1894 practically all the citrus fruits were destroyed and in 1895 and 1899 the trees in the north and north central portions were killed. During the past century there have been at least seven severe freezes in this State, during two of which—1835 and 1899—practically a zero temperature prevailed over the interior or northern and western counties. These marked temperature extremes have stimulated speculation as to climatic changes, the solution of which, however, still lacks a true physical basis. The mean temperature for the State is 70.3°. The warmest month is July, with an average temperature of 81.2°; the coldest is January, with an average of 57.6°. The mean maximum temperature is 79.9°; the mean minimum temperature is 61.1°. The highest temperature recorded during the past twelve years, since the Climate and Crop Service was established, was 107°; the lowest temperature recorded during the same period was -2°. These figures represent also the extremes of temperature, so far as authentic records go, from the time Florida was a foreign province to the present day. It is a fact worthy of note that while January, upon the average, is the coldest month, the greatest disasters resulting from severe cold waves occurred during December and February. Adverting to maximum temperatures, and by way of correcting the opinion of some who believe extreme heat is dependent on latitude, it may be well to point out that there are stations in the southeast portion of the State where maximum temperatures have never exceeded 94°.

Precipitation.—Precipitation results during the summer mainly from the operation of heat and moisture, the lower layers of air becoming unstable as a result of solar radiation. Winter rains result from the eastward movement of storm areas which usually originate in Texas. The amount of precipitation and the area affected thereby are dependent upon the intensity of the disturbances and their eastward track. The total annual rainfall at some stations occasionally shows marked variations, due to the number, near approach, and intensity of cyclonic storms during summer and autumn. The annual precipitation is greatest—about 60 inches—on the Gulf borders of the extreme west portion and over a limited section of the southwest peninsula—mainly Dade and the southern portion of Brevard County. It is least in the extreme southern portion of the State, where the normal rainfall is about 35 inches. Comparatively speaking, there is a rainy season and dry season, the former beginning usually in June, when the average rainfall is about 7 inches, and ending,

on an average, with September. Precipitation diminishes in October, followed by seven comparatively dry months, although February and March indicate a second period of maximum precipitation. April and November are the dryest months, with July, August, and September the wettest. The greatest monthly rainfall ever recorded—31.26 inches—occurred in August. Precipitation is heaviest over the western portion of the State during July and August and over central and southern sections during September. The annual average precipitation for the State is 54.53 inches.

—*From Climatology of the United States.* Bulletin 2. U. S. Weather Bureau.

Books of Travel as an Aid to the Teaching of Geography.—Mrs. F. D. Herbertson publishes in the *School World* for December a suggestive and helpful list of books of travel available for school supplementary work. The books suggested for Europe are as follows:

Austria-Hungary.

Ansted, Prof. D. J. "A Short Trip in Hungary and Transylvania." (W. H. Allen.)
Asboth, J. de. "Official Tour through Bosnia." (Sonnenschein.)
Kohl, J. G. "Austria." (Chapman and Hall.)
Grohmann, W. A. "The Land of the Mountains." (Simpkin, 1907.)
Munro, R. "Rambles and Studies in Bosnia, Herzegovina, and Dalmatia." (Blackwood.)
Palmer, F. H. E. "Austrian Life in Town and Country." (Newnes.)

Balkan States, Turkey, and Greece.

"Bulgaria of To-day." Official Publication of the Bulgarian Ministry of Commerce and Agriculture, 1907.
Durham, M. E. "Through the Lands of the Serb." (Arnold, 1904.)
Fraser, J. F. "Pictures from the Balkans." (Cassell, 1906.)
Garnett, L. "Turkish Life in Town and Country." (Newnes.)
Lavaleye, E. de. "The Balkan Peninsula." English translation. (Fisher Unwin, 1887.)
Lear, E. "Journals of a Landscape Painter in Albania." (Bentley.)
Menzies, S. "Turkey Old and New." (W. H. Allen.)
Mahaffy, J. P. "Rambles and Studies in Greece." (Macmillan.)
Miller, W. "Greek Life in Town and Country." (Newnes.)
Odysseus (Sir C. Eliot). "Turkey in Europe." (Arnold, 1900.)
Samuelson, J. "Rumania," (Kegan Paul, 1888.)
Vivian, H. "Servia." (Longmans.)

Denmark, Sweden, Norway, Iceland.

Bisiker, W. "Across Iceland." (Arnold, 1902.)
Bröchner, J. "Danish Life in Town and Country." (Newnes.)
Du Chaillu, P. "Land of the Midnight Sun." 2 vols. (Murray, 1881.)
Dufferin, Lord. "Letters from High Latitudes." (Murray.)

Forrester, G. "Rambles in Norway." (Longmans, 1855.)
Hansen, Prof. "Norway." Official Publication for the Paris Exhibition.
Heidenstam, O. G. "Swedish Life in Town and Country." (Newnes.)
"Sweden." Official Handbook published for the Paris Exhibition.

France.

Baring-Gould, S. "Deserts of Southern France." (Methuen, 1894.)
"Book of the Cevennes." (Long, 1907.)
Betham-Edwards, M. E. "A Year in Western France." (Longmans.)
"France of To-day." (Percival.)
"Holidays in Eastern France." (Hurst and Blackett.)
Hugo, V. "Alpes et Pyrénées." English translation. (Sands.)
Lynch. "French Life in Town and Country." (Newnes.)
Marcel, E. A. "Les Cevennes et la Région des Causses." (Paris: Delegrave.)
Reclus, O. "La France et ses Colonies." (Hachette.)
Taine, H. "Garnets de Voyage." (Paris.)

Germany, Holland, and Belgium.

Baring-Gould, S. "Germany." (Sampson Low.)
Blackburn, H. "The Harz Mountains." (Sampson Low.)
Boulger, D. "Belgian Life in Town and Country." (Newnes.)
Dawson, W. H. "German Life in Town and Country." (Newnes.)
Hough, P. M. "Dutch Life in Town and Country." (Newnes.)
Macdonnell, A. A. "Camping Voyages in German Waters." (Stanford, 1889.)
Mahaffy, J. F., and Rogers, J. E. "Sketches from a Tour through Holland and Germany." (Macmillan, 1889.)

Italy.

Deecke, Prof. W. "Italy." (Sonnenschein, 1904.)
Gauthier, Théophile. "Voyage en Italie."
Hare, A. J. C. "Venice." (Allen.)
"Walks in Rome" (Allen, 1892.)
Howells, W. D. "Tuscan Cities." (Edinburgh: Douglas.)
Villari, L. "Italian Life in Town and Country." (Newnes, 1902.)

Portugal.

Crawford, O. "Round the Calendar in Portugal." (1890.)
Hume, Martin. "Through Portugal." (Grant Richards, 1907.)

Russia.

Palmer, F. H. E. "Russian Life in Town and Country." (Newnes, 1906.)
Trevor-Battye, A. A. "Northern Highway of the Tsar." (Constable, 1898.)
Wallace, Sir D. "Russia." 2 vols. (Cassell, 1905.)
Windt, H. de. "Finland as it is." (Murray, 1901.)

Spain.

Ford, R. "Handbook for Travelers in Spain." First edition. (Murray, 1845.)
Gadow, H. "In Northern Spain." (Black, 1897.)
Gauthier, Théophile. "Voyage en Espagne." (Paris: Charpentier.)
Hare, A. J. C. "Wanderings in Spain." (Allen.)
Higgens, L. "Spanish Life in Town and Country." (Newnes, 1902.)

Switzerland.

Story, A. T. "Swiss Life in Town and Country." (Newnes, 1902.)
Tschudi, F. von. "Sketches of Nature in the Alps." (Out of print.)
Innumerable mountaineering books.

How Matches are Made.—The civilized nations of the world strike three million matches every minute of the twenty-four hours. Nearly one-half of these are ignited in this country. Americans use up the enormous total of seven hundred billion a year, and have a larger match bill than any other nation in the world.

Hundreds of factories over the country are engaged in this industry, about which the general public knows but little. Some of the plants are very large; one on the Pacific Coast covers 240 acres, and has thirty-two miles of railroad to supply the match machines with 200,000 feet of sugar pine and yellow pine logs a day.

A statement of the number of cubic feet of wood which actually is converted into matches each year would convey only an inadequate idea of the number of trees required for the industry. For the manufacture of the match, the best grade of wood is necessary. Sapwood, knotty, or cross-grained timber will not do. This makes it necessary to search the best forests and pick out the choice trees only, and nothing but the choice portions of the choice trees go to the match machines. It may be seen that the lumberman sweeps over a wide area in search of suitable timber to feed into the match machines.

Seldom is the little splinter tipped with sulphur given even a scanty mention in considering the depletion of the world's finest forests; yet the manufacturers of these little fire sticks are as much concerned over the timber supply question as any other class of woodworkers. No scraps or left-over material can be put into matches. This is because the wood has to be cut into such extremely small portions, each of which must be strong enough to avoid breaking when the match is scratched. Therefore the rejected timber from the match factories is good enough to be made into many articles of a larger size; and the by-product end of the match business becomes the largest end, so far as bulk is concerned. Among the by-products made by the large Pacific Coast factory just mentioned are 1,000 doors and 800 sashes daily.

As a matter of fact, it would be impossible to carry on the match business at all, at present prices, if the rejected lumber were not worked into something else. The room where matches are made is frequently the smallest department of a match factory. The larger portions contain the sawmills and planing mills where doors, sash, shingles, lath, siding, posts,

cordwood, and many other salable commodities are made ready for market.

This country, although it has the most abundant material and the finest machinery in the world for the purpose, does not manufacture enough matches to supply the home market. Thousands of dollars' worth are annually imported from Germany, Austria, France, Sweden, and other countries where they are made by cheaper labor and poorer machinery, and usually from higher-priced wood, though it is not better than what is grown in the American forests. The imports are largely safety matches, which can be struck only on the box or other specially prepared surface.

Wood for matches is a much more serious problem in some of the European countries than it is as yet in the United States. The most suitable match timbers are pine, linden, aspen, white cedar, poplar, birch, and willow. Others, however, are occasionally used. Germany imports willow and aspen from Russia. Some time ago the German match manufacturers petitioned the minister of agriculture to cause the foresters to plant aspen in the state forests to supply wood for matches without importing it. A similar petition to their government was presented by the French manufacturers of matches, who wanted a home supply. At the same time the Russian manufacturers of matches asked their government to take measures to check the export of match wood to foreign countries, because the material was needed at home.

In the United States, as well as in Canada, a diligent search for choice forests is maintained, and very large tracts have been bought by companies in the match business, not only to meet present demands, but to provide for years to come. In a single year one match company cut 225 million board feet of pine in the Lake region. The cut in that instance was exceptionally large, however, in order to save timber which was threatened by the ravages of a bark beetle. There are more than 150 match manufacturers in the United States, and about half that number in Canada.

Some matches are shaved with the grain from sawed blocks, some are cut both ways by saws. In some factories the blocks are boiled to make them cut easily. By some machines a boiled or steamed log is revolved on its own axis and a shaving—the thickness of a match—is cut round and round. This shaving is at the same time cut into lengths and split into match sticks. There is hardly a limit to the varieties of methods employed. Round matches are made by forcing them through dies. The Japanese make paper matches, which are wood after all.

—*Forestry and Irrigation.*